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ABSTRACT

Career information concerning jobs in the electricity-electronics field is presented. Included is an overview of all positions of employment in the field, such as professional engineers, technicians, skilled craft workers, and semi-skilled workers. A description of their work, training requirements, and employment outlook is given. Information is also provided concerning the educational and training opportunities in the electricity-electronics field available in Mississippi: secondary vocational, part-time cooperative vocational, postsecondary vocational and technical, and apprenticeship programs. Finally, career information is presented about the telephone industry, the electric power industry, and the electronics manufacturing industry--each as an employer of workers with training in all levels of electricity-electronics. (This publication has been developed to complement the manual entitled Electricity-Electronics for Industrial Arts, CE 018 615.) (JH)

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PREFACE

This publication has been developed to complement the manual entitled **Electricity-Electronics for Industrial Arts.** Teachers who are using this manual in their programs are introducing their students to the world of electricity-electronics and providing them with valuable hands-on experiences in this area. As a result, many students are discovering a real interest and aptitude in the electricity-electronics field. Interests, however, may wither and die unless the industrial arts teacher is quick to capitalize on them and provide these students with real and meaningful information concerning career opportunities in the electricity-electronics field.

Today students want to know the types of jobs found in the electricity-electronics field and what must they do to become qualified for such jobs. The purpose of this material is to put that information in the hands of the industrial arts teacher who in turn can relate it to their students.

Career information is presented concerning jobs in the electricity-electronics field. This includes an overview of all levels of employment in the field such as the professional engineer, technicians, skilled crafts workers, and the semi-skilled worker. A description of their work, training requirements, and employment outlook are presented which should be of interest to students. Information is also included concerning the educational and training opportunities available in Mississippi.

A brief description and career information is presented about the telephone industry, electric power industry, and the electronics manufacturing industry. These industries employ vast numbers of workers with background and training in all levels of electricity-electronics.

Most of the material presented in this manual was obtained from the 1976-77 edition of the **Occupational Outlook Handbook** published by the United States Government Printing Office. For additional information concerning particular jobs or industries, the teacher should refer to the Handbook. Most school libraries have copies.

Appreciation is extended to Mr. Larry L. Godfrey, State Supervisor of Industrial Arts Education, for suggestions pertaining to the instructional procedures recommended for this publication. Acknowledgment is also extended to the various companies which contributed the pictures appearing throughout the publication.

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[1]Hinrichs, Roy S. "Electricity-Electronics for Industrial Arts", **Research and Curriculum Unit for Vocational and Technical Education**, Mississippi State University, 1976, 103 pp.

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INSTRUCTIONAL PROCEDURES

One of the goals of industrial arts is to provide exploratory experiences combined with occupational information to enable students to make sound career choices. This publication contains occupational information concerning careers in the electricity-electronics field. Obviously, this information should be combined and taught along with the exploratory experiences that students are receiving in electricity-electronics.

The responsibility for introducing the students to this occupational information rests upon the industrial arts teacher. After this introduction, however, the learning responsibility can be shifted to the students.

Industrial arts teachers should carefully review the material in this publication and prepare a lesson to present to the students. Be sure to emphasize in the lesson why students should be concerned with occupational information. (You will find this information in the PREFACE.) In this lesson the manual should be shown and the various sections explained to the students. Finally in this lesson, student responsibility for reports should be assigned and an explanation of the reports should be presented.

Divide the class into groups of three of four students per group. Each group should be assigned one of the various sections of the publication for reporting purposes. The teacher may want to suggest a required time limit for each oral report. Each group should be assigned a specific date to deliver their report to the class. As a suggestion, the teacher may choose to set aside the first part of Tuesday and Thursday classes for reporting.

For reports to be meaningful and worthwhile for all students, adequate time must be given in which to prepare the reports. The teacher should occasionally check with each group to determine that proper preparation is being done.

The first report presented usually sets the pattern for the ones to follow. With this fact in mind, the teacher may wish to give a little more help and supervision to the first reporting group to assure that the report is well prepared and delivered.

Multicopies of the publication have been provided. They are to be used by students when preparing reports. These publications may either be placed in the school library or kept in the industrial arts laboratory. If most of the students have a study hall period; and if they are allowed to go to the library during that period, then there would appear to be an advantage in placing at least two of the copies on limited reserve in the library.

SUPPLEMENTARY INSTRUCTIONAL AIDS

No additional materials or aids are needed in implementing the subject matter contained in this publication into the industrial arts program. Field trips, however, if they can be arranged are a learning experience for students. A tour through an electrical power generating plant, substation, telephone company building, or local electricity-electronics manufacturing plant would provide valuable occupational information for students concerning occupations and working conditions in the electricity-electronics field.

OBJECTIVES

1. To make students aware of the employment opportunities in the electrical-electronics industry.

2. To make students aware of the educational and training requirements needed for entry into occupations within the electrical-electronics industries.

3. To provide students with information concerning select industries employing large numbers of workers in the electricity-electronics field.

4. To provide students with information concerning the educational and training opportunities available in Mississippi for preparation for careers in the electrical-electronics industries.

INTRODUCTION

During the past few years, the large numbers of unemployed in the United States has received much attention. One has only to read the daily paper, listen to radio, or watch television to verify this fact. During this same time, however, many jobs could not be filled for lack of trained personnel.

Job opportunities have been available in the electricity-electronics field. For the past decade, the electricity-electronics field has been one of the country's fastest growing industries. All indications are that the industry will continue to grow. This will call for an ever increasing supply of trained personnel not only to meet the needs of an expanding industry, but also to replace those presently working who will retire.

The industrial arts course in which this publication is being used today could very well be responsible for many students entering careers in the electricity-electronics field. This course will not qualify students for jobs, however, it could give many students an introduction to electricity-electronics in which they may discover interests and talents. With the correct guidance and career information, these students may pursue these interests and talents and seek education and training to prepare for entry into the electricity-electronics field. The industrial arts teacher has the responsibility to see to it that students enrolled in the course receive this information.

INSTRUCTIONAL ACTIVITIES

This manual was developed to provide the teacher with the kinds of career information necessary in any successful industrial arts program. In turn, the industrial arts teacher should plan to incorporate this material into his/her instructional program. Suggestions for doing this have been presented in the INSTRUCTIONAL PROCEDURE section of the manual.

The career information that follows in this publication consists of the following:

1. General career information about the engineer, the technician, and the skilled craft worker; and specific career information concerning these personnel and their work in the electricity-electronic field.

2. Specific information concerning the educational and training opportunities available in Mississippi for the above mentioned career.

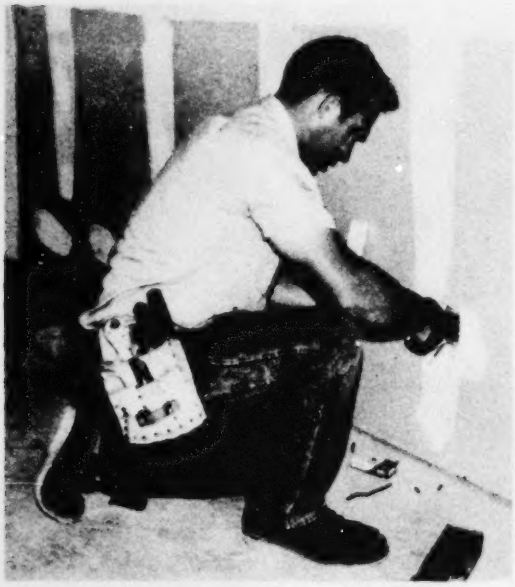
3. General information about three industries, which due to the very nature of their work, employ large numbers of personnel with education and training in electricity-electronics.

CAREERS IN THE ELECTRICAL TRADES

CONSTRUCTION ELECTRICIANS

Nature of the Work

Heat, light, power, air-conditioning, and refrigeration components all operate through electrical systems that are assembled, installed, and wired by construction electricians. These workers also install electrical machinery, electronic equipment, controls, and signal and communications systems. Construction electricians follow blueprints and specifications for most installations. To install wiring in factories and offices, they may bend and fit conduit (pipe or tubing) inside partitions, walls, or other concealed areas. They then pull insulated wires or cables through the conduit to complete the circuit between outlets and switches. In lighter construction, such as housing, plastic-covered wire is usually used rather than conduit. In any case, electricians connect the wiring to circuit breakers, transformers, or other components. Wires are joined by soldering or mechanical means. When the wiring is finished, they test the circuits for proper connections and grounding.



An electrician installing a wall outlet

Electricians, for safety reasons, must follow National Electrical Code regulations and, in addition, must fulfill requirements of state, county, and municipal electrical codes.

Electricians generally furnish their own tools, including screwdrivers, pliers, knives, and hacksaws. Employers furnish heavier tools, such as pipe threaders, conduit benders, and most test meters and power tools.

Places of Employment

Most of the 245,000 construction electricians employed in 1974 worked for electrical contractors. Many others were self-employed contractors. A small number of electricians worked for government agencies or businesses that do their own electrical work. Construction electricians are employed throughout the country, but are concentrated in industrialized and urban areas.

Training, Other Qualifications, and Advancement

Electricians learn the trade through one of several methods of training. These include the vocational or trade schools, apprenticeship programs, or by working as helpers and observing experienced

electricians. Many learn the trade in the armed service.

To qualify for an apprenticeship, an applicant must be at least 18 years old and usually must be a high school or vocational school graduate with 1 year of algebra. Courses in electricity, electronics, mechanical drawing, science, and shop provide a good background. Although physical strength is not essential, manual dexterity, agility, and good health are important. Good color vision is necessary because electrical wires frequently are identified by color.

To obtain a license, which is necessary for employment in most cities, an electrician must pass an examination which requires a thorough knowledge of the craft and of state and local building codes.

Experienced construction electricians can advance to supervisors, superintendents, or contract estimators for contractors on construction jobs. Many electricians start their own contracting businesses. In most large urban areas, a contractor must have a master electrician's license.

Employment Outlook

Employment of construction electricians is expected to increase faster than the average for all occupations through the mid-1980's. As population and business grow, more electricians will be needed to install electrical fixtures and wiring in new homes, offices, and other buildings. In addition to jobs created by employment growth, many openings will arise as experienced electricians retire, die, or transfer to other occupations.

While employment in this field is expected to grow over the long run, it may fluctuate from year to year due to ups and downs in construction activity. When construction jobs are not available, however, electricians may be able to transfer to other types of electrical work. For example, they may find jobs as maintenance electricians in factories, or jobs as electricians in ship-building or aircraft manufacturing.

Earnings and Working Conditions

According to a survey of metropolitan areas, union wage rates for electricians averaged $8.96 an hour in 1974, compared with $8.16 for all union building trade workers. Because the seasonal nature of construction work affects electricians less than workers in most building trades, their annual earnings also tend to be higher.

Apprentice wage rates start at from 40 to 50 percent of the rate paid to experienced electricians and increase periodically.

Construction electricians are not required to have great physical strength, but they frequently must stand for long periods and work in cramped quarters. Because much of their work is indoors, electricians are less exposed to unfavorable weather than are most other construction workers. They risk electrical shock, falls from ladders and scaffolds, and blows from falling objects. However, safety practices have helped to reduce the injury rate.

A large proportion of construction electricians are members of the International Brotherhood of Electrical Workers.

Sources of Additional Information

For details about electrician apprenticeships or other work opportunities in this trade, contact local electrical contractors; a local union of the International Brotherhood of Electrical

Workers; a local union-management apprenticeship committee, or the nearest office of the state employment service or state apprenticeship agency. Some local employment service offices screen applicants and give aptitude tests.

For general information about the work of electricians, contact:

International Brotherhood of Electrical Workers, 1125 15th St. NW., Washington, D.C. 20005.

National Electrical Contractors Association, 1730 Rhode Island Ave. NW., Washington, D.C. 20036.

National Joint Apprenticeship and Training Committee for the Electrical Industry, 1730 Rhode Island Ave. NW., Washington, D.C. 20036.

MAINTENANCE ELECTRICIANS

Nature of the Work

Maintenance electricians keep lighting systems, transformers, generators, and other electrical equipment in good working order. They also may install new electrical equipment.

Duties vary greatly, depending on where the electrician is employed. Electricians who work in large factories may repair particular items such as motors and welding machines. Those in office buildings and small plants usually fix all kinds of electrical equipment. Regardless of location, electricians spend much of their time doing preventive maintenance—periodic inspection of equipment to locate and correct defects before breakdowns occur. When trouble occurs, they must find the cause and make repairs quickly to prevent costly production losses. In emergencies, they advise

These maintenance electricians are measuring voltage at distribution panel.

management whether continued operation of equipment would be hazardous, necessitating a shutdown.

Maintenance electricians make repairs by replacing items such as fuses, circuit breakers, or switches. When installing new or replacing existing wiring, they splice wires and cut and bend conduits (pipes) through which the wires are run.

Maintenance electricians sometimes work from blueprints, wiring diagrams, or other specifications. They use meters and other testing devices to locate faulty equipment. To make repairs they use pliers, screwdrivers, wirecutters, drills, and other tools.

Places of Employment

An estimated 280,000 maintenance electricians were employed in 1974. More than half of them worked in manufacturing industries; large numbers worked in plants that make automobiles, machinery, chemicals, aluminum, and iron and steel. Many maintenance electricians also were employed by public utilities, mines,

railroads, and by federal, state, and local governments.

Training, Other Qualifications, and Advancement

Electricians learn the trade through one of several methods of training. These include the vocational or trade schools, apprenticeship programs, or by working as helpers and observing experienced electricians. Many learn the trade in the armed service.

Persons interested in becoming maintenance electricians can obtain a good background by taking high school or vocational school courses in electricity, electronics, algebra, mechanical drawing, shop, and science. To qualify for an apprenticeship program, an applicant must be at least 18 years old and usually must be a high school or vocational school graduate with 1 year of algebra.

Although physical strength is not essential, manual dexterity, agility, and good health are important. Good color vision is necessary because electrical wires frequently are identified by color.

Because the electrician's craft is subject to constant technological change, many experienced electricians continue to learn new skills. For example, some maintenance electricians who entered the trade years ago must now learn basic electronics.

All maintenance electricians should be familiar with the National Electric Code and local building codes. Many cities and counties require maintenance electricians to be licensed. Electricians can get a license by passing an examination that tests their knowledge of electrical theory and its application.

Some maintenance electricians become supervisors. Occasionally, they advance to jobs such as plant electrical superintendent or plant maintenance superintendent.

Changing a lamp in a recessed light fixture

Maintenance electricians must be able to repair or replace any type of electrical equipment.

Employment Outlook

Employment of maintenance electricians is expected to increase faster than the average for all occupations

through the mid-1980's. This growth will stem from increased use of electrical and electronic equipment by industry. In addition to the jobs from employment growth, a few thousand openings will arise each year to replace experienced electricians who retire, die, or transfer to other occupations.

Growth in the number of job openings is expected to be fairly steady in the years ahead since the demand for maintenance electricians is not very sensitive to ups and downs in the economy. At times when construction activity is depressed, however, beginners may face competition for job openings because some unemployed construction electricians apply for these openings.

Earnings and Working Conditions

Earnings of maintenance electricians compare favorably with those of other skilled workers. In early 1974, based on a survey of metropolitan areas, maintenance electricians averaged $5.34 an hour, ranging from $3.74 in Manchester, N.H. to $6.21 in Chicago. In about four-fifths of the cities surveyed, hourly averages for these workers ranged from $4.50 to $6.

Apprentices start at about 60 percent of the skilled electrician's hourly pay rate and receive increases every 6 months.

During a single day, an electrician may repair equipment both in a clean, air-conditioned office and on the factory floor, surrounded by the noise, oil, and grease of machinery. Electricians often climb ladders or work on scaffolds in awkward or cramped positions.

Because maintenance electricians work near high-voltage industrial equipment, they must be alert and accurate. Errors in wiring installations could endanger both the electrician and other employees. Safety principles, which are a part of all electrician training programs, have reduced the frequency of accidents. Electricians are taught to use protective equipment and clothing, to respect the destructive potential of electricity, and to fight small electrical fires.

Among unions organizing maintenance electricians are the International Brotherhood of Electrical Workers; the International Union of Electrical, Radio and Machine Workers; the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America (Ind.); and the United Steelworkers of America.

Sources of Additional Information

Information about apprenticeships or other work opportunities in the trade is available from local firms that employ maintenance electricians, and from local union-management apprenticeship committees. In addition, the local office of the State employment service may provide information about training opportunities. Some State employment service offices screen applicants and give aptitude tests.

CAREERS IN TECHNICIAN OCCUPATIONS

Technician occupations are growing rapidly because of the needs of an expanding and increasingly technical economy matched to the growing recognition of the importance of technicians. This section is concerned with the technicians who work with engineers and scientists, and with draftsmen, also usually considered technicians.

Nature of the Work

The term "technician," as used here, refers to workers whose jobs require both knowledge and use of scientific and mathematical theory; specialized education or training in some aspect of technology or science; and who, as a rule, work directly with scientists and engineers. There is no generally accepted definition of the term "technician." For example, it is used by employers to refer to workers in a great variety of jobs, requiring a wide range of education and training. The term is applied to employees doing relatively routine work, to persons performing work requiring skills within a limited sphere, and to persons doing highly technical work, among them assistants to engineers and scientists.

The workers' job titles may be descriptive of their technical level (for example, biological aid, or engineering technician) or their work activity (for example, quality-control technician, production analyst, tool designer, materials tester, or time-study analyst). Some employers use the word "technician," preceded by adjectives, such as mechanical, electrical, electronics, or chemical, which describes areas of technology in which their personnel are employed.

The jobs of engineering and science technicians are more limited than those of the professional engineer or scientist, and have a greater practical orientation. Many technician jobs require the ability to analyze and solve engineering and science problems and to prepare formal reports on experiments, tests, or other projects. Most of these jobs require some aptitude in mathematics; others, the ability to visualize objects and to make sketches and drawings. Design jobs often require creative ability. Many technician jobs require some familiarity with one or more of the skilled trades, although not the ability to perform as a craftsman. Others demand extensive knowledge of industrial machinery, tools, equipment, and processes. Some jobs held by these technicians are supervisory and require both technical knowledge and the ability to supervise people.

In carrying out their assignments, engineering and science technicians frequently use complex electronic and mechanical instruments, experimental

This technician wires computer panels with the aid of a computer controlled system she is watching. (IBM)

laboratory apparatus, and drafting instruments. Almost all of the technicians whose jobs are described in this statement must be able to use engineering handbooks and computing devices, such as the slide rule or calculating machine.

Technicians engage in virtually every aspect of engineering and scientific work. In research, development, and design, one of the largest areas of employment, they conduct experiments or tests; set up, calibrate, and operate instruments; and make calculations. They also assist scientists and engineers in developing experimental equipment and models by making drawings and sketches and, under the engineer's direction, frequently do some design work.

Technicians also work in jobs related to production, usually following a program course laid out by the engineer or scientist, but often without close supervision. They may aid in the various phases of production operation, such as working out specifications for materials and methods of manufacture, devising tests to insure quality control of products, or making time-and-motion studies (timing and analyzing the worker's movements) designed to improve the efficiency of a particular operation. They also may perform liaison work between engineering and production or other departments.

Technicians often do work that might otherwise have to be done by engineers. They may serve as technical sales or field representatives of manufacturers; advise on installation and maintenance problems of complex machinery; or write specifications and technical manuals.

Electronics Technology. This field includes radio, radar, sonar, telemetering, television, telephony, and other forms of communication; industrial and medical measuring, recording, indicating, and controlling devices; navigational equipment; missile and spacecraft

An electronics measurement unit being assembled by a technician. (Northrup Corp.)

guidance and control instruments; electronic computers; and many other types of equipment using vacuum tubes, transistors, semiconductors, and printed circuits. Because the field is so broad, technicians generally become specialists in one area—for example, induction or dielictric heating, servomechanisms, automation controls, or ultrasonics.

Technicians working with engineers and scientists in the field of electronics do complex technical work that is more difficult than routine operating and repair work.

Places of Employment

As estimated 650,000 engineering and science technicians, not including draftsmen and surveyors, were employed in 1970—about 11 percent were women. Nearly 460,000 of these technicians (more than 7 out of 10) were employed by private industry. The manufacturing industries

Electrical components are carefully checked by a technician before being assembled into the final product. (Medtronics, Inc.)

employing the largest numbers of engineering and science technicians were electrical equipment, chemicals, machinery, and aerospace. In the nonmanufacturing sector, large numbers of technicians were employed in the communications industry and by engineering and architectural firms.

In 1970, the Federal Government employed over 85,000 engineering and science technicians; chiefly as engineering aids and technicians, electronic technicians, equipment specialists, cartographic aids, meteorological technicians, and physical science technicians. Of these engineering and science technicians, the largest number worked for the Department of Defense. Most of the others were employed by the Departments of Transportation, Agriculture, Interior, and Commerce.

State Government agencies employed nearly 50,000 engineering and science technicians in 1970 and local governments about 12,000. The remainder were employed by colleges and universities, mostly in university-operated research institutes, and by nonprofit organizations.

Training, Other Qualifications, and Advancement

Young men and women who wish to prepare for careers as engineering or science technicians can obtain the necessary training from a great variety of educational institutions or can qualify for their work right on the job. Most employers, however, seek workers who have had some form of specialized training for more responsible technician jobs. Specialized formal training programs are offered in post-secondary schools—technical institutes, junior and community colleges, area vocational technical schools, and extension divisions of colleges and universities—as well as in technical and technical-vocational high schools. Other ways in which persons can become qualified for technician jobs are by completing an on-the-job training program, through work experience and formal courses taken on a part-time basis in post-secondary or correspondence schools, or through training and experience obtained while serving in the Armed Forces. In addition, many engineering and science students who have not completed all the requirements for a bachelor's degree, as well as some other persons having a college education in mathematics and science, are able to qualify for technician jobs after they obtain some additional technical training and experience. In general, post-secondary school technical training is required for a growing number of engineering and science technician jobs.

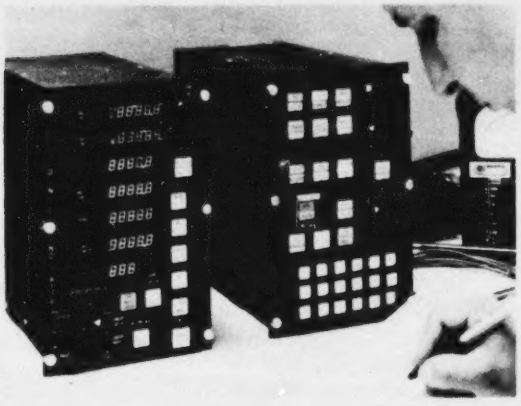
Engineering and science technicians usually begin work as trainees or in the more routine positions under the direct supervision of an experienced technician, scientist, or engineer. As they gain

CAREERS IN ENGINEERING

The work of engineers affects our lives in thousands of different ways. Their past accomplishments have enabled us to drive safer automobiles, reach the moon, and even prolong life through special machinery. Future accomplishments could help us obtain energy self-sufficiency, develop more pollution-free powerplants and aid medical science's fight against disease.

In 1974, more than 1.1 million persons were employed as engineers, the second largest professional occupation exceeded only by teachers. About 1 percent of all engineers were women. The number of women engineers is expected to increase in the future, since enrollments of women in engineering programs have increased sharply over the past several years.

Most engineers specialize in one of the more than 25 specialties recognized by professional societies. Within the major branches are over 85 subdivisions. Structural, environmental, hydraulic, and highway engineering, for example, are subdivisions of civil engineering.



Electrical engineers design a variety of products such as this control panel used in the navigation system of the C-5A Galaxy aircraft. (Northrup Corp.)

Engineers may also specialize in the engineering problems of one industry, such as motor vehicles, or in a particular field of technology, such as propulsion or guidance systems. Since knowledge of basic engineering principles is required for all areas of engineering, it is possible for engineers to shift from one branch or field of specialization to another, especially during the early stages of their careers. This section, which contains an overall discussion of engineering, is followed by separate statements on 12 branches of the profession—aerospace, agricultural, biomedical, ceramic, chemical, civil, electrical, industrial, mechanical, metallurgical, mining, and petroleum engineering.

NATURE OF THE WORK

Engineers develop electric power, water supply, and waste disposal systems to meet the problems of urban living. They design machines and artificial organs which save countless numbers of lives. They design industrial machinery and equipment used to manufacture goods; and heating and air-conditioning for more comfortable living. Engineers also develop scientific equipment to probe outer space and the ocean depths, and design, plan, and supervise the construction of buildings, highways, and rapid transit systems. They design and develop consumer products such as automobiles, television sets, and refrigerators, and systems for control and automation of manufacturing, business, and management processes.

Engineers must consider many factors in developing a new product. For example, in developing new devices to reduce automobile exhaust emissions, engineers must determine the general nature of the

device, calculate and test all components, and fit them together in an integrate plan. They must then evaluate the overall effectiveness of the new device, as well as its cost and reliability. These factors are applicable to most products, including those as different as artificial hearts, electronic computers, or industrial machinery.

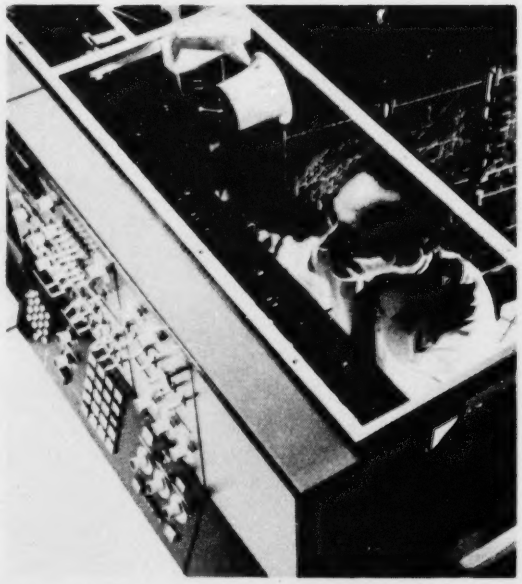
In addition to design and development, engineers work in testing, production, or operation and maintenance. Still others are in administrative and management jobs where an engineering background is necessary, or in sales where they discuss the technical aspects of a product and assist in planning its installation or use. Engineers with considerable experience sometimes work as consultants or teach in the engineering schools of colleges and universities.

Engineers within each of the branches may apply their specialized knowledge to many fields. Electrical engineers, for example, work in medicine, computers, missile guidance, or electric power distribution. Because engineering problems are usually complex, the work in some fields cuts across the traditional branches. Using a team approach to solve problems, engineers in one field often work closely with specialists in other scientific, engineering, and business occupations.

Many engineers work under quiet conditions in modern offices and research laboratories. Others, however, spend time in more active work—in a factory or mine, at a construction site, or some other outdoor location.

PLACES OF EMPLOYMENT

More than half of all engineers work in manufacturing industries—mostly in the electrical equipment, aircraft and parts, machinery, chemicals, scientific instruments, primary metals, fabricated metal products, and motor vehicle industries. Over 330,000 were employed in nonmanufacturing industries in 1974, primarily in construction, public utilities, engineering and architectural services, and business and management consulting services.



This engineer is making an electrical contact check in the console of the computer.

Federal, state, and local governments employed more than 150,000 engineers. Over half worked for the Federal Government, mainly in the Departments of Defense, Interior, Agriculture, Transportation, and in the National Aeronautics and Space Administration. Most engineers in state and local government agencies worked in highway and public works departments.

Colleges and universities employed about 43,000 engineers in research and teaching jobs, and a small number worked for nonprofit research organizations.

TRAINING, OTHER QUALIFICATIONS, AND ADVANCEMENT

A bachelor's degree in engineering is the generally accepted educational requirement for beginning engineering jobs. College graduates trained in one of the natural sciences or mathematics also may qualify for some beginning jobs. Experienced technicians with some engineering education are sometimes able to advance to engineering jobs.

Graduate training is being emphasized for an increasing number of jobs; it is essential for most beginning teaching and research positions, and desirable for advancement. Some specialties, such as nuclear engineering, are taught mainly at the graduate level.

About 280 colleges and universities offer a bachelor's degree in engineering. Although programs in the larger branches of engineering are offered in most of these institutions, some small specialties are taught in only a very few. Therefore, students desiring specialized training should investigate curriculums before selecting a college. Admissions requirements for undergraduate engineering schools usually include high school courses in advanced mathematics and the physical sciences.

In a typical 4-year curriculum, the first 2 years are spent studying basic sciences—mathematics, physics, chemistry, introductory engineering—and the humanities, social sciences, and English. The last 2 years are devoted, for the most part, to specialized engineering courses. Some programs offer a general engineering curriculum, permitting the student to choose a specialty in graduate school or acquire it on the job.

Some engineering curriculums require more than 4 years to complete. A number of colleges and universities now offer 5-year master's degree programs. In addition, several engineering schools have formal arrangements with liberal arts colleges whereby a student spends 3 years in liberal arts and 2 years in engineering and receives a bachelor's degree from each.

Some schools have 5- or even 6-year cooperative plans where students coordinate classroom study and practical work experience. In addition to gaining useful expereince, students can finance part of their education. Because of the need to keep up with rapid advances in technology, engineers often continue their education throughout their careers in programs sponsored by employers, or in colleges and universities after working hours.

All 50 States and the District of Columbia require licensing for engineers whose work may affect life, health, or property, or who offer their services to the public. In 1974, about 350,000 engineers were registered. Generally, registration requirements include a degree from an accredited engineering school, 4 years of relevant work experience, and the passing of a State examination.

Engineering graduates usually begin work under the supervision of experienced engineers. Many companies have special programs to acquaint new engineers with special industrial practices and to determine the specialties for which they are best suited. Experienced engineers may advance to positions of greater responsibility; those with proven ability often become administrators and increasingly larger numbers are being promoted to top executive jobs. Some engineers obtain graduate degrees in business administration to improve their advancement opportunities, while still others obtain law degrees and become patent attorneys.

Engineers should be able to work as part of a team and have creativity, an

analytical mind, and a capacity for detail. They should be able to express their ideas well orally and in writing.

EMPLOYMENT OUTLOOK

Employment opportunities for engineers are expected to be good through the mid-1980's. Opportunities for recent graduates of engineering schools are expected to be very good since the number of new graduates is expected to fall short of the number needed to fill the thousands of openings created by employment growth, and the need to replace those who die, retire, or transfer to other occupations. Because of the expected shortage, many openings will be filled by upgraded technicians and college graduates from related fields.

Employment requirements for engineers are expected to grow faster than the average for all occupations through the mid-1980's. Much of this growth will stem from industrial expansion to meet the demand for more goods and services. More engineers will be needed in the design and construction of factories, electric power-plants, office buildings, and transportation systems, as well as in the development and manufacture of more advanced computers, scientific instruments, industrial machinery, chemical products, and motor vehicles.

Many engineers will be required in energy-related activities developing new sources of energy as well as designing energy-saving systems for automobiles, homes, and other buildings. Engineers also will be needed to solve environmental pollution problems.

Defense spending will also affect the outlook for engineers, since a large number work in defense-related activities. The long-range outlook for engineers given here is based on the assumption that defense spending will increase from its 1974 level by the mid-1980's, but will still be somewhat lower than the peak levels of the 1960's. If, however, defense activity differs substantially from the level assumed, the demand for engineers will differ from that now expected.

Since so many factors affect overall employment requirements, opportunities for engineers fluctuate periodically. In the short run, the available engineering jobs can either exceed or fall short of the number of persons looking for jobs, but over the long run, engineers can look forward to good job opportunities.

SOURCES OF ADDITIONAL INFORMATION

General information on engineering careers—including student selection and guidance, professional training, and salaries—is available from:

Engineers' Council for Professional Development, 345 E. 47th St., New York, N.Y. 10017.

Engineering Manpower Commission, Engineers Joint Council, 345 E. 47th St., New York. 10017.

National Society of Professional Engineers, 2029 K St. N.W., Washington, D.C. 20006.

TRAINING AND EDUCATIONAL OPPORTUNITIES AVAILABLE IN MISSISSIPPI

Formal training and education are available in Mississippi to prepare individuals for entry into all levels of careers in the electricity-electronics field. The State Division of Vocational-Technical Education sponsors training programs at both the secondary (high school) and post secondary (junior college) levels leading to entry jobs in the skilled crafts. The SDVTE also sponsors programs for technician training at most of the junior colleges throughout the state. Four-year degree programs in Electrical Engineering are offered at Mississippi State University and the University of Mississippi.

In addition to these, other training opportunities are available in Mississippi in the area of electricity-electronics. These opportunities include apprenticeship training for the electrical trades and on-the-job training offered by the many industries in Mississippi engaged in work in the electricity-electronics field. Examples of these industries are the Telephone Company, the Power and Light Companies, and industries manufacturing electricity-electronics products.

SECONDARY VOCATIONAL PROGRAMS

Vocational programs at the high school level to prepare students for entry into the electrical trades are in operation throughout Mississippi. These programs are offered as part of the regular high school curriculum. Students are required to be at least 16 years of age. High school credit is earned for successful completion of the program.

Students attend the vocational class for three hours each day. The remainder of the school day is devoted to regular academic subjects. These programs lead to both a trade certificate and a high school diploma.

Secondary vocational programs for the electrical trades are offered at the following schools:

Natchez—Adams Vocational Complex—Natchez
Alcorn County Vocational Complex—Corinth
Houston Vocational Complex—Houston
West Point Vocational Complex—West Point
DeSoto County Vocational Complex—Southaven
Hinds County Vocational Complex—Raymond
Clinton Vocational Complex—Clinton
Humphreys County Vocational Complex—Belzoni
Pascagoula Vocational Complex—Pascagoula
Bay Springs High School—Bay Springs
Jefferson Davis County Vocational Complex—Carson
A. P. Fatheree Vocational Complex—Laurel
John C. Stennis Vocational Complex—DeKalb
Ross Collins Vocational Complex—Meridian
Harris Campus—Meridian
Tupelo Vocational Complex—Tupelo
Greenwood Vocational Complex—Greenwood
Columbia—Marion County Vocational Complex—Columbia
Amory Vocational Complex—Amory

North Panola Vocational Complex—Como
Poplarville High School—Poplarville
Pontotoc Ridge Area Vocational Complex—Pontotoc
Prentiss County Vocational Complex—Booneville
Smith County Vocational Complex—Raleigh
New Albany Vocational Complex—New Albany

PART-TIME COOPERATIVE VOCATIONAL EDUCATION

In communities where secondary vocational programs for the electrical trades are not offered, students should be encouraged to consider part-time cooperative vocational education. These programs are a cooperative effort between the local school and the community to offer vocational training. The cooperative programs in which a student can study the electrical trades would be either the T & I Coop, or the Diversity Occupational Coop, whichever is offered at the high school the student attends.

To be eligible, students must be 16 years of age or older and enrolled in the high school. In such programs, students usually spend one hour each day in the coop class where related information is taught; two hours per day in regular academic subjects; and three hours each day at an assigned work station in the community where the skills of the trade are learned under the supervision of an experienced craftsman. Students are paid while at work in this program. In addition, students earn high school credit for both the coop class and the work experience. Such a program leads to a high school diploma. Additional information concerning these programs can be obtained from the T & I Coordinator or the D. O. Coordinator at the high school.

Secondary schools offering part time cooperative vocational education in Mississippi are:

North Natchez—Adams High
South Natchez—Adams High
Alcorn Central High
Biggersville High
Corinth High
Cleveland High
Bruce High
Calhoun City High
Okolona High
Houston Vocational Center
West Point High
Coahoma County High
Clarksdale High
Collins High
Hernando High
Horn Lake High
Southaven High
S. H. Blair Center, Hattiesburg
George County High, Lucedale
Leakesville High
Grenada High
Bay Senior High, Bay St. Louis
Biloxi High
Gulfport High
d'Iberville High, North Biloxi
Harrison Central High, Gulfport
Forest Hill High, Jackson
Clinton High
Lanier Senior High, Jackson
Itawamba A. H. S., Fulton
Ocean Springs High
Moss Point Central High
Vancleave High
East Central High, Hurley
Pascagoula Vocational Complex, Pascagoula
Northeast Jones High, Laurel
South Jones High, Ellisville
West Jones High, Laurel
Watkins High, Laurel
Oxford High
Ross Collins Vocational Complex, Meridian
Aberdeen High
Amory Vo-Tech Center
Philadelphia High
Neshoba Central High, Philadelphia
Newton High
Union High
Starkville Vocational Center

North Panola Vocational Complex, Como
South Panola Vocational Complex, Batesville
Picayune High
Poplarville High
Richton High
McComb Vocational Complex
Pontotoc Co. Vocational Complex
Baldwyn High
Thrasher High, Booneville
Pearl-McLaurin High, Pearl
Sharkey-Issaquena Vocational, Rolling Fork
Magee Attendance Center
Taylorville High
Mendenhall Attendance Center
Stone County High, Wiggins
Senatobia High
Walnut High
Ripley High
Iuka High
New Albany Vocational School
Vicksburg H. S. Complex
Greenville High
Leland Vocational Complex
Louisville Vocational Complex
Water Valley High
Yazoo City High

POST SECONDARY VOCATIONAL PROGRAMS

Vocational programs in Industrial Electricity are offered at a number of junior colleges in Mississippi. Applicants for these programs must be 16 years of age or older, and have graduated from high school or have successfully completed the GED test. If not meeting these qualifications, students can be admitted into their programs as special students on a provisional basis.

Students in these programs attend school all day, five days a week for nine months.

Junior colleges offering post secondary vocational programs, in Industrial Electricity are:

East Central Jr. College
East Mississippi Jr. College, Golden Triangle Center
Hinds Jr. College, Raymond Center
Itawamba Jr. College, Tupelo Center
Meridian Jr. College
Mississippi Delta Jr. College
Mississippi Gulf Coast Jr. College, Jackson County Center and Jeff Davis Center
Northeast Mississippi Jr. College
Pearl River Jr. College, Poplarville Center
Southwest Mississippi Jr. College

POST SECONDARY TECHNICAL PROGRAMS

Technical programs in ELECTRONICS TECHNOLOGY are offered at a number of the junior colleges in Mississippi. These programs offer excellent preparation for a variety of jobs in the electronics field at the technician level.

Applicants for these programs must be high school graduates with a score of at least 10 on the ACT. These programs are two years in length and lead to an Associate of Applied Science Degree.

Junior colleges offering the ELECTRONICS TECHNOLOGY curriculum in Mississippi are:

Coahoma Jr. College
Copiah-Lincoln Jr. College
Hinds Jr. College, Raymond Center
Itawamba Jr. College, Fulton Center and Tupelo Center
Jones Jr. College
Meridian Jr. College
Mississippi Delta Jr. College
Mississippi Gulf Coast Jr. College, Jackson County Center
Northeast Mississippi Jr. College
Northwest Mississippi Jr. College
Pearl River Jr. College, Poplarville Center
Utica Jr. College

APPRENTICESHIP TRAINING

Apprenticeship training for the electrical trades is available in many areas of Mississippi.

Apprenticeship programs are sponsored through and supervised by local union-management committees. These programs provide 144 hours of classroom instruction each year in addition to comprehensive on-the-job training. In the classroom, apprentices learn blueprint reading, electrical theory, electronics, mathematics, and safety and first-aid practices. On the job, under the supervision of experienced electricians, apprentices must demonstrate mastery of electrical principles. At first, apprentices drill holes, set anchors, and set up conduit. In time and with experience, they measure, bend, and install conduit, as well as install, connect, and test wiring. They also learn to set up and draw diagrams for entire electrical systems.

To qualify for an apprenticeship, an applicant must be at least 18 years old and usually must be a high school or vocational school graduate with one year of algebra. Courses in electricity, electronics, mechanical drawing, science, and shop provide a good background. Although physical strength is not essential, manual dexterity, agility, and good health are important. Good color vision is necessary because electrical wires frequently are identified by color.

In Mississippi, apprenticeship programs for electrical trades are found in Corinth, Gulfport, Jackson, Laurel, and Meridian. These programs are sponsored jointly by the International Brotherhood of Electrical Workers and the National Electrical Contractors of America. Additional information can be secured from the Training Directors in the cities listed above.

UNIVERSITY PROGRAMS

Degree programs in electrical engineering are offered at Mississippi State University and at the University of Mississippi. These programs are four years in length and lead to a Bachelor of Science degree.

Applicants must be high school graduates. A strong background in mathematics and science is recommended.

All of the state's public supported junior colleges offer two year pre-engineering programs. Students desiring to become professional engineers could attend one of the junior colleges for two years and transfer this work to Mississippi State University or the University of Mississippi.

THE ELECTRIC POWER INDUSTRY

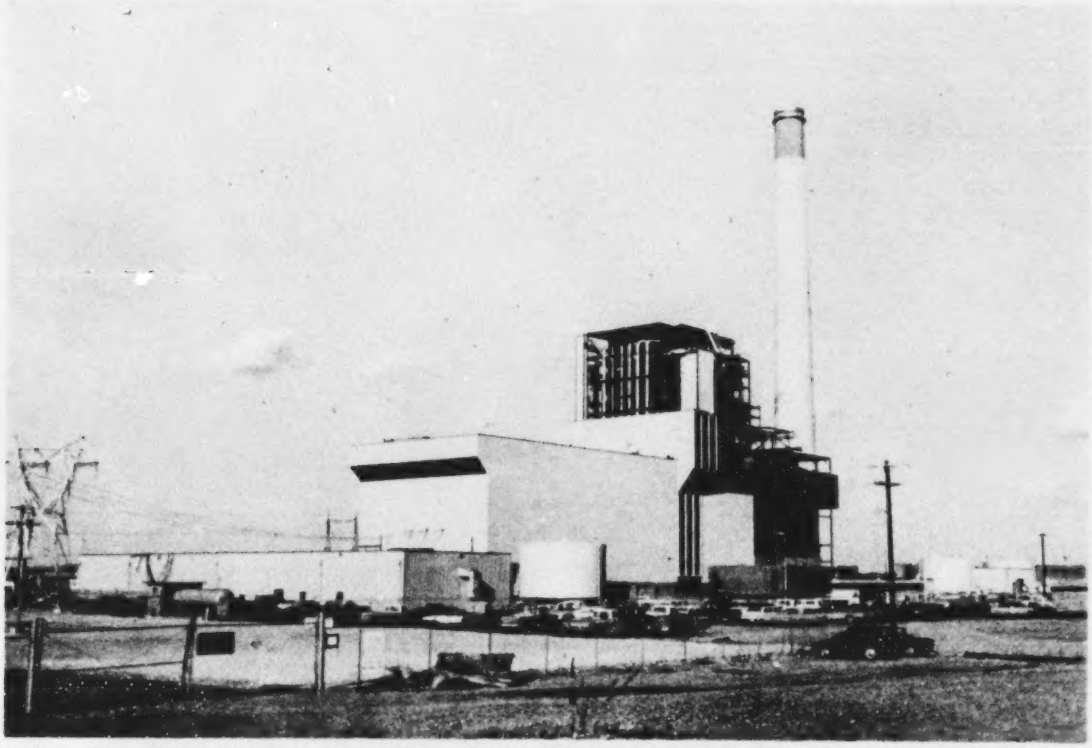
Electricity has become so much a part of our daily lives that most people take it for granted. But just imagine not being able to ride the elevator to your apartment and instead having to walk up all those flights of stairs. Or think about having no lights, television set, or radio in your home. Today, it would be difficult to get used to living without electricity.

Bringing electricity into our homes and places of work and recreation is not as simple as just turning on a switch. There are thousands of employees working in the electric power industry to make all this possible.

Nature and Location of the Industry

The delivery of electricity to users at the instant they need it is the unique feature of the electric power systems. Electricity cannot be stored efficiently but must be used as it is produced. Because a customer can begin or increase the use of electric power at any time by merely flicking a switch, an electric utility system must have sufficient capacity to meet peak consumer needs at any time.

An electric utility system includes powerplants that generate electric power, substations that increase or decrease the



An electrical power generating plant (Mississippi Power and Light Company)

voltage, and vast networks of transmission and distribution lines. Electric utilities range from large systems serving broad regional areas to small power companies serving individual communities. Most electric utilities are investor-owned (private) or owned by cooperatives; others are owned by cities, counties, and public utility districts, as well as by the Federal Government. While some utilities generate, transmit, and distribute only electircity, others distribute both electricity and gas. This chapter is concerned with employment relating only to the production and distribution of electric power.

Producing and distributing large quantities of electrical energy involves many processes and activities. The accompanying chart shows how electric energy is generated, and how it travels from the generating station to the users.

The first step in providing electrical energy occurs in a generating station or plant, where huge generators convert mechanical energy into electricity. Electricity is produced primarily in steam-powered generating plants which use coal, gas, oil, or nuclear energy for fuel. In addition, a considerable amount of electricity is produced in hydroelectric generating stations which use water power to operate the turbines. Still other generators, primarily for use in standby service or to provide electricity for special purposes, are powered by diesel engines or gas turbines.

After electricity is generated, it passes through a "switchyard," where the voltage is increased so that the electricity may travel long distances without excessive loss of power. The electricity passes onto transmission lines that carry it from the generating plant to substations, where the voltage is decreased and passed on to the distribution networks serving individual customers. Transmission lines tie together the generating stations of a single system and also the power facilities of several systems. In this way, power can be interchanged among several utility systems to meet varying demands.

In 1974, 550,000 people worked in the electric power industry. Most of them, 465,000, worked in investor-owned utilities and cooperatives and 80,000 worked in Federal and municipal government utilities. A few large manufacturing establishments, which produce electric power for their own use, also employ electric power workers.

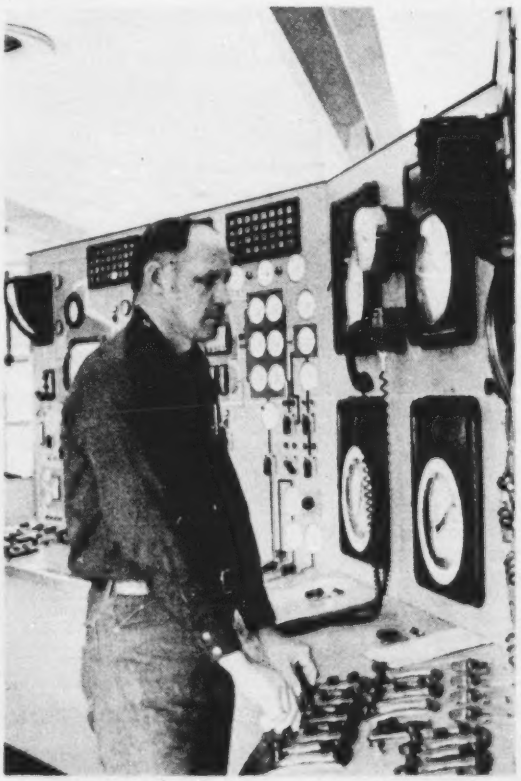
As new homes are built, they must be supplied with electricial power. (Mississippi Power and Light Company)

Since electricity reaches almost every locality, jobs in this industry are found throughout the country. Although hydroelectric power projects have created jobs in relatively isolated areas, most utility jobs are still found in heavily populated urban areas.

Electric Utility Occupations. Many different types of workers are required in the electric power industry. About 40 percent of the industry's employees work in occupations related to the generation, transmission, and distribution of electricity, and in customer service occupations. (These occupations are discussed in detail later in this chapter.) The industry also employs large numbers of workers in engineering, scientific, administrative, sales, clerical, and maintenance occupations. A brief discussion on these occupations is given below.

Engineering and Scientific Occupations. Engineers plan generating plant construction and additions, interconnections of complex power systems, and installations of new transmission and distribution systems and equipment. They supervise construction, develop improved operating methods, and test the efficiency of the many types of electrical equipment. In planning modern power systems, engineers help select plantsites, types of fuel, and types of plants. Engineers also help industrial and commercial customers make the best use of electric power.

Administrative and Clerical Occupations. Because of the enormous amount of recordkeeping required, electric utilities employ many administrative and clerical personnel. Large numbers of stenographers, typists, bookkeepers, office machine operators, file clerks, accounting and auditing clerks, and cashiers are employed. These workers keep records of the services rendered by the company, make up bills for customers, and prepare a variety of statements and statistical reports. An increasing amount of this work in the larger offices now is being performed by computers. This generally results in more clerical work being done either by fewer or by the same number of employees. The use of this equipment also creates a need for programmers and computer operators. Administrative employees include accountants, personnel officers, purchasing agents, and lawyers.



Switchboard operators control the amount of electric power flowing from the generating plant. (Mississippi Power and Light Company)

Maintenance Occupations. A considerable number of workers test, maintain, and repair equipment. The duties of these skilled craft workers are

similar to those of maintenance workers in other industries. Among the more important skilled workers are electricians, instrument repairers, maintenance mechanics, machinists, pipefitters, welders, dispatchers, and boilermakers.

POWERPLANT OCCUPATIONS

Nature of the Work

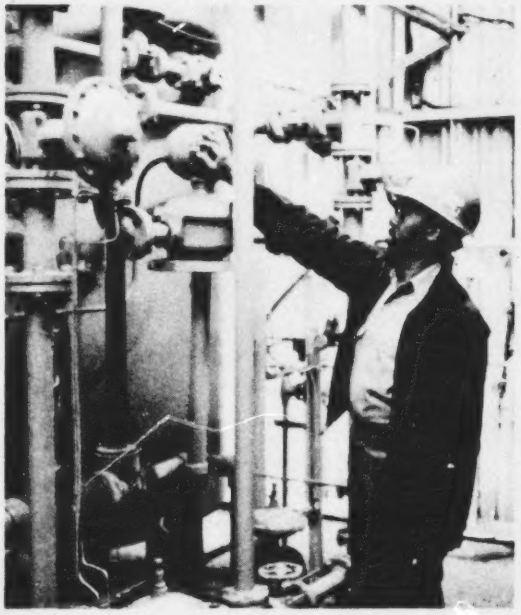
Operators are key workers in a powerplant. They include four basic classes—boiler, turbine, auxiliary equipment, and switchboard. These operators observe, control, and keep records of the operation of various kinds of powerplant equipment. They make sure that the equipment functions efficiently and detect any trouble that arises. In many new steamplants, including nuclear, these jobs are combined; operators and their assistants are known as steam operators, powerplant operators, or central control room operators.

Of increasing importance are the maintenance personnel, including electrical, instrument, and mechanical repairers. Other powerplant workers include helpers and cleaners, and the custodial staff, including janitors and guards. In steam generating plants using coal for fuel, coal handlers are employed. In hydroelectric plants, gate tenders open and close the headgates that control the flow of water to turbines. Supervision of powerplant operations is handled by cheif engineers called operations supervisors, and by their assistants, watch engineers (called shift supervisors).

Boiler operators—employed only where steam generates electricity—regulate the supplies of fuel, air, and water in the boilers and maintain proper steam pressure to turn the turbines. Pressure is measured by gauges, meters, and other instruments mounted on panel boards. One employee may operate one or more boilers.

Turbine operators control the operation of steam or water-powered turbines that drive the generators. In small plants, they also may operate auxiliary equipment or a switchboard. Since modern steam turbines and generators operate at extremely high speeds, pressures, and temperatures, the operator must give close attention to the pressure gauges, thermometers, and other instruments showing the operations of the turbo-generator unit. Turbine operators record the information shown by these instruments and check the oil pressure at bearings, the speed of the turbines, and the circulation and amount of cooling water in the condensers that change the steam. They also are responsible for starting and shutting down the turbines and generators, as directed by the switchboard operator in the control room. Other workers, such as helpers and junior operators, assist the turbine operators.

Auxiliary equipment operators check and record the readings of instruments that indicate the operating condition of



Auxiliary equipment operator. (Mississippi Power and Light Company)

pumps, fans, blowers, condensers, evaporators, water conditioners, compressors, and coal pulverizers. Since auxiliary equipment may occasionally break down, these operators must be able to detect trouble quickly, and sometimes make minor repairs. In small plants which do not employ auxiliary equipment operators, these duties are performed by turbine operators.

Switchboard operators control the amount of electric power flowing from generators to outgoing powerlines by watching instrument panels and by operating switchboards. Switches control the movement of electricity through the generating station circuits and onto the transmission lines. Instruments mounted on panelboards show the power demands on the station at any instant, the powerload on each line leaving the station, the amount of current being produced by each generator, and the voltage.

The operators use switches to distribute the power demands among the generators, to combine the current from two or more generators, and to regulate the flow of the electricity onto various powerlines. When power requirements change, they order generators started or stopped and, at the proper time, connect them to the power circuits in the station or disconnect them. In doing this, they follow telephone orders from the load dispatcher who directs the flow of current throughout the system.

Switchboard operators and their assistants also check their instruments frequently to see that electricity is moving through and out of the powerplant properly, and that correct voltage is being maintained. Among their other duties, they keep records of all switching operations and of load conditions on generators, lines and transformers. They obtain this information by making regular meter readings.

High towers carry transmission lines which are erected and maintained by the power company. (Mississippi Power and Light Company)

Control room operator. In most powerplants constructed in recent years, the operation of boilers, turbines, auxiliary equipment, and the switching required for balancing generator output has been centralized in a single control room. Here, central control room operators or powerplant operators regulate all the generating equipment, which in older plants requires specialists such as boiler and turbine operators. Control room operators have several assistants who patrol the plant and check the equipment. Operators report to the plant superintendent or a watch engineer when equipment is not operating properly.

Watch engineers or shift supervisors oversee the employees who operate and maintain boilers, turbines, generators, transformers, and other machinery and equipment. Watch engineers are

supervised by a chief engineer or a plant superintendent who is in charge of the entire plant.

Generally, a nuclear-powered plant requires about the same kind and number of employees as a steam-generating plant powered by coal. However, nuclear plants employ a few additional employees such as health and safety specialists.

Training, Other Qualifications, and Advancement

New powerplant workers generally begin at the bottom of the ladder—usually on cleanup jobs. Such work gives beginners an opportunity to become familiar with the equipment and operations of a powerplant. They advance to the more responsible job of helper, as openings occur. Formal apprenticeships in these jobs are rare. Applicants generally are required to have a high school or vocational school education.

It takes from 1 to 3 years to become qualified as an auxiliary equipment operator and from 4 to 8 years to become a boiler operator, turbine operator, or switchboard operator. A person learning to be an auxiliary equipment operator progresses from helper to junior operator to operator. A boiler operator generally spends from 2 to 6 months as a laborer before being promoted to the job of helper. Depending on openings and the worker's aptitude, the helper may advance to junior boiler operator and eventually to boiler operator, or transfer to the maintenance department and work up to boiler repairer. Turbine operators advance from the ranks of auxiliary equipment operators and are often selected from other plants.

In many states and large cities, employees who operate equipment in powerplants must be licensed by local or state agencies. While licensing requirements often vary from place to place, the National Institute for the Uniform Licensing of Power Engineers (NIULPE) is attempting to standardize these requirements.

Some powerplant workers employed in atomic-powered electric plants must have special training to work with nuclear fuel, in addition to the knowledge and skills required for conventional steam-generated electric power. All control room operators, assistant control room operators, and some operators of high pressure auxiliary equipment in nuclear powerplants must be licensed by the Nuclear Regulatory Commission.

Where a system has a number of generating plants of different size, operators usually first get experience in the smaller stations and then are promoted to jobs in the larger stations as vacancies occur.

New workers in the switchboard operators section begin as helpers, advance to junior operators, and then to switchboard operators. Some utility companies promote substation operators to switchboard operating jobs. The duties of both classes of operators have much in common. Switchboard operators can advance to work in the load dispatcher's office.

Watch engineers are selected from among experienced powerplant operators. At least 5 to 10 years of experience as a first-class operator are usually required to qualify for a watch engineer's job.

Earnings and Working Conditions

The earnings of powerplant workers vary by occupation and locality.

A powerplant is typically well lighted and ventilated, clean, and orderly, but there is some noise from the equipment.

Switchboard operators in the control room often sit at the panel boards, but

boiler and turbine operators are almost constantly on their feet. The work of powerplant operators generally is not physically strenuous, particularly in the new powerplants. Since generating stations operate 24 hours a day, 7 days a week, some powerplant employees must work nights and weekends, usually on rotating shifts.

TRANSMISSION AND DISTRIBUTION OCCUPATIONS

Nature of the Work

One-fourth of the workers in the electric power industry are in transmission and distribution jobs. The principal workers in these jobs are those who control the flow of electricity—load dispatchers and substation operators—and employees who construct and maintain powerlines—line installers and repairers, cable splicers, troubleshooters, ground helpers, and laborers. Line installers and repairers make up the largest single occupation in the industry.

Load dispatchers also called system operators or power dispatchers, control the flow of electricity throughout the area served by the utility. The load dispatcher's room is the nerve center of the entire utility system. From this location, the load dispatcher controls the plant equipment used to generate electricity and directs its flow. Dispatchers telephone instructions to the switchboard operators at the generating plants and the substations, telling them when additional boilers and generators are to be started or stopped so that power production will be in balance with power needs.

The load dispatcher must anticipate demands for electric power so that the system will be prepared to meet them. Power demands on utility systems may change from hour to hour. A sudden afternoon rainstorm may cause a million lights to be switched on in a matter of minutes.

Dispatchers also direct the handling of any emergency situation, such as transformer or transmission line failure, and route current around the affected area. They also may be in charge of interconnections with other systems and directing transfers of current between systems as the need arises.

The load dispatchers' source of information for the entire transmission system is the pilot board. This board, which dominates the load dispatcher's room, is a complete map of the utility's transmission system. It enables the dispatcher to determine, at a glance, the conditions that exist at any point in the system. Lights may show the positions of switches which control generating equipment and transmission circuits, as well as high voltage connections with substations and large industrial customers. The board also may have several recording instruments which make a graphic record of operations for future analysis and study.

Substation operators generally are responsible for the operation of the substation. Under orders from the load dispatcher, they direct the flow of current out of the station by means of a switchboard. Ammeters, voltmeters, and other types of instruments on the switchboard register the amount of electric power flowing through each line. The flow of electricity from the incoming to the outgoing lines is controlled by circuit breakers. The substation operators connect or break the flow of current by manipulating switchboard levers that control the circuit breakers. In some substations, where alternating current is changed to direct current to meet the needs of special users, the operator controls converters which perform the change.

In addition to switching duties, substation operators check the operating condition of all equipment to make sure that it is working properly. They supervise the activities of the other substation employees on the same shift. In small substations, the operator may be the only employee.

Some utilities employ a mobile operator who drives from one automatic station to another, inspecting powerlines, operating controls, and assisting customers' electricians in large commercial or government installations. Since this job requires a considerable degree of independent judgment, the mobile operator is usually more experienced than the substation operator.

Line installers and repairers construct and maintain the network of powerlines that carries electricity from generating plants to consumers. Their work consists of installations, equipment replacements, repairs and routine maintenance. When wires, cables, or poles break, it means an emergency call for a linecrew. Line repairers splice or replace broken wires and cables and replace broken insulators or other damaged equipment. Most installers and repairers now work from "bucket" trucks with pneumatic lifts that take them to the top of the pole at the touch of a lever. In some power companies, linecrew employees specialize in particular types of work. Those in one crew may work on new construction only, and others may do only repair work.

Trouble shooters are experienced line installers and repairers who are assigned to special crews that handle emergency calls. They move from one job to another, as ordered by a central service office which receives reports of line trouble. Often troubleshooters receive their orders by direct radio communications with the central service office.

Trouble shooters are experienced line installers and repairers who are assigned to special crews to handle emergency calls. (Mississippi Power and Light Company)

These workers must have a thorough knowledge of the company's transmission and distribution network. They first locate and report the source of trouble and then attempt to restore service by making the necessary repairs. Depending on the

nature and extent of the problem, troubleshooters may restore service, or simply disconnect and remove the damaged equipment. They must be familiar with all the circuits and switching points so that they can safely disconnect live circuits.

Ground helpers dig poleholes and help line installers and repairers erect the poles or towers which carry the distribution lines. Line installers bolt crossarms to the poles and bolt or clamp insulators in place on the crossarms. Ground helpers then help the installers raise the wires and cables and install them on the poles by attaching them to the insulators. In addition, with assistance from ground helpers, line installers attach a wide variety of equipment to the poles, such as lightning arrestors, transformers, and switches.

Cable splicers install and repair insulated cables on utility poles and towers, as well as those buried underground or those installed in underground conduits. When cables are installed, the cable splicers pull the cable through the conduit and then join the cables at connecting points in the transmission and distribution systems. At each connection in the cable, they wrap insulation around the wiring. They splice the conductors leading away from each junction of the main cable, insulate the splices, and connect the cable sheathing. Most of the physical work in placing new cables or replacing old ones is done by laborers.

Cable splicers spend most of their time repairing and maintaining cables and changing the layout of the cable systems. They must know the arrangement of the wiring systems, where the circuits are connected and where they lead to and come from. When making repairs, they must make sure that the conductors do not become mixed up between the substation and the customer's premises. Cable splicers also periodically check insulation on cables to make sure it is in good condition.

Training, Other Qualifications, and Advancement

Load dispatchers are selected from experienced switchboard operators and from operators of large substations. Usually, 7 to 10 years of experience as a senior switchboard or substation operator are required for promotion to load dispatcher. To qualify for this job, an applicant must have knowledge of the entire utility system.

Substation operators generally begin as assistants or junior operators. Advancement to the job of operator in a large substation requires from 3 to 7 years of on-the-job training. About 4 years of on-the-job training are needed to qualify as a skilled line installer and repairer. Some companies have formal apprenticeship programs for line employees. Apprenticeship programs combine on-the-job training with classroom instruction in bluepring reading, elementary electrical theory, electrical codes, and methods of transmitting electrical energy.

Apprentices usually begin training by helping ground helpers set poles in place and by passing tools and equipment up to line installers and repairers. After about 6 months, apprentices begin to do simple linework under close supervision, and progress to more difficult work as they gain experience. The training of line installers and repairers who learn their skills on the job generally is similar to the apprenticeship program; it usually takes about the same length of time, but does not involve classroom instruction. A line installer and repairer may advance to troubleshooter after several years of experience.

Candidates for linework should be strong and in good physical condition since work involving climbing poles and lifting lines and equipment is strenuous. They also must have steady nerves and good balance to work at the top of the

poles and to avoid the hazards of live wires and falls.

Most cable splicers get their training on the job, usually taking about 4 years to become fully qualified. Workers begin as helpers and then are promoted to assistant or junior splicers. In these jobs, they are assigned more difficult tasks as their knowledge of the work increases.

Earnings and Working Conditions

The earnings of customer service workers vary according to the type of job they have and the section of the country in which they work.

Wages for transmission and distribution workers vary by occupation and geographic location.

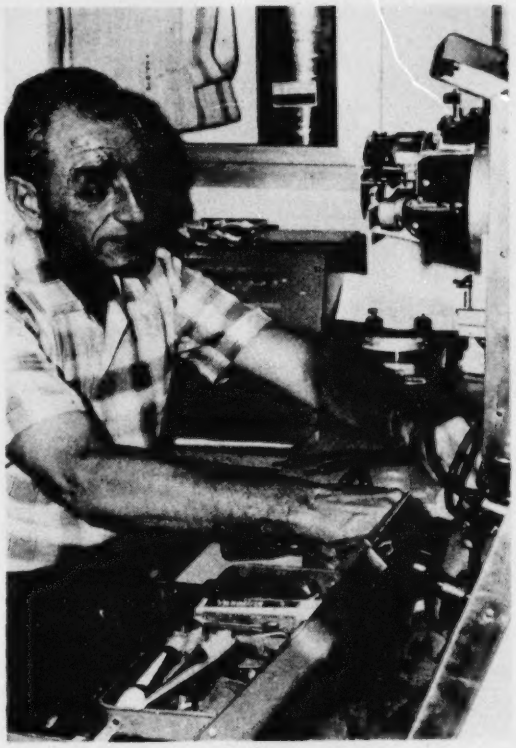
Load dispatchers and substation operators generally work indoors in pleasant surroundings. Line installers and repairers, troubleshooters, and ground helpers work outdoors. In emergencies, they may work in all kinds of weather. Cable splicers do most of their work in manholes beneath city streets—often in cramped quarters. Safety standards developed over the years by utility companies, with the cooperation of labor unions, have greatly reduced the hazards of these jobs.

CUSTOMER SERVICE OCCUPATIONS

Nature of the Work

Workers in customer service occupations include people who install, test, and repair meters; meter readers; company agents in rural areas; and appliance repairers.

Electric meter repairers are the most skilled workers in this group. They install, test, maintain, and repair meters on customers' premises. Some repairers can handle all types of meters, including the more complicated ones used in industrial plants and other places where large quantities of electric power are used. Others specialize in repairing the simpler kinds, like those in homes. Often, some of the large systems require specialists, such as **meter installers** and **meter testers.** Installers put in and take out meters. Testers specialize in testing the small meters used in homes and some of the more complicated ones used by commercial and industrial customers.



Meter repairer at work (Mississippi Power and Light Company)

Meter readers go to customers' premises to check meters which register the amount of electric energy used. They record the amount of electricity used in a specific period so that each customer can be charged for the correct amount. They also watch for, and report, any tampering with meters.

District representatives usually serve as company agents in outlying districts which are too small to justify more specialized workers. They collect overdue bills; make minor repairs; and read, connect, and disconnect meters. They receive and send service complaints and reports of line trouble to a central office.

Training, Other Qualifications, and Advancement

Meter repairers begin their jobs as helpers in the meter testing and repair departments. Persons entering this field should have a basic knowledge of electricity. About 4 years of on-the-job training are required to become a fully qualified meter repairer. Some companies have formal apprenticeship programs in which the trainee progresses according to a specific plan.

Inexperienced workers can qualify as meter readers after a few weeks of training. Beginners accompany the experienced meter reader on the rounds until they have learned the job.

The duties of district representatives are learned on the job. An important qualification for this occupation is the ability to deal tactfully with the public in handling service complaints and collecting overdue bills.

Employment Outlook

Employment in the electric power industry is expected to increase about as fast as the average for all industries through the mid-1980's. The greater use of electric power in industrial processes, growth of commercial centers, and population growth will all contribute to an increased demand for electricity. However, due to the growing use of automatic controls, employment will not increase as fast as electric power production.

Trends in growth will differ from one occupation to another in the industry. The need for scientific engineering and technical employees is expected to increase sharply as construction of power generating plants increases and as research into developing more efficient energy usage to combat shortages and higher prices of fossil fuels becomes necessary. Much of this increase in employment will be in the development and construction of new nuclear power facilities.

In many other occupations in this industry, only slight increases in employment are expected. Larger, more efficient powerplants will limit growth of employment of powerplant employees. The increased use of electronic data processing equipment for billing and recordkeeping will restrict growth in some clerical jobs. In occupations which will experience little or no growth, most job openings will result from the need to replace workers who die, retire, or leave the electric power industry for other reasons.

People hired by electric power companies should have relatively secure jobs. Even during downturns in the economy, these companies seldom lay off employees.

Earnings and Working Conditions

Earnings in the electric utility industry are relatively high. In 1974, non-supervisory employees in private electric power companies averaged $5.55 an hour. By comparison, the average for all non-supervisory workers in private industry, except farming, was $4.22 an hour.

Because supplying electricity is a 24-hour, 7-day-a-week activity, some employees work evenings, nights, and weekends, usually on rotating shifts. Most union contracts with electric utilities

provide a higher rate of pay for evening and nightwork than the basic day rate.

Overtime work is often required, especially during emergencies such as floods, hurricanes, or storms. During an "emergency callout," which is a short-notice request to report for work during nonscheduled hours, the worker generally is guaranteed a minimum of 3 or 4 hours pay at 1-1/2 times the basic hourly rate. Travel time to and from the job is counted as worktime.

In addition to these provisions which affect pay, electric utilities provide other employee benefits. Generally, annual vacations are granted to workers according to length of service. A typical contract or employee benefit program provides for a 1-week vacation for 6 months to 1 year of service, 2 weeks for 1 to 10 years, and 3 weeks for 10 to 20 years. Some contracts and programs provide for 4 weeks after 18 years, for 5 weeks after 25 years, and 6 weeks after 30 years. The number of paid holidays ranges from 6 to 12 a year. Nearly all companies have benefit plans for their employees. A typical program provides life, hospitalization, and surgical insurance and paid sick leave. Retirement pension plans supplement Federal social security payments and generally are paid for in full or in part by the employer.

Because of the dangers of electrocution and other hazards, electric utilities and unions have made intensive efforts to enforce safe working practices. This has resulted in an injury rate lower than in most manufacturing industries. However, some occupations, especially those on linecrews, are more subject to accidents than others.

Many nonsupervisory electric utility workers in production, transmission, and distritution departments are union members. The bargaining representative for most of these workers is either the International Brotherhood of Electrical Workers or the Utility Workers Union of America. Independent unions represent some utility workers.

Sources of Additional Information

Information about jobs in the electric power industry is available from local electric utility companies, from industry trade associations, or from the local offices of unions that represent electric utility workers. Additional information also may be obtained from:

Edison Electric Institute, 90 Park Ave., New York, N.Y. 10016.

International Brotherhood of Electrical Workers, 1125 15th St. NW , Washington, D.C. 20005.

Utility Workers' Union of America, 1875 Connecticut Ave. NW , Washington, D.C. 20006.

THE TELEPHONE INDUSTRY

About 600 million local and long distance telephone calls are made daily in the United States and overseas. In 1974, approximately 975,000 employees provided this daily service.

The telephone industry offers steady, year-round employment in many different jobs. Some jobs, such as telephone operator and file clerk, can be learned in a few weeks; others, such as installer and repairer, require many months.

Nature and Location of the Industry

Providing telephone service for the many millions of residential, commercial, and industrial customers is the main work of the Nation's telephone companies. More than 144 million telephones were in use in the United States in 1974.

Telephone jobs are found in almost every community. Most telephone workers, however, work in cities having large concentrations of industrial and business establishments. The nerve center of the local telephone system is the central office that has the switching equipment through which a telephone may be connected with any other telephone. Every call travels from the caller through wires and cables to the cable vault in the central office. Thousands of pairs of wires fan out from the cable vault to a distributing frame where each set of wires is attached to switching equipment. Electromechanical and electronic switching equipment make connections automatically. In a few remaining switchboards and in unusual situations an operator makes the connection.

Some customers make and receive more calls than a single telephone line can handle. For this larger volume of calls, a system somewhat similar to a miniature central office may be installed on the customer's premises. This system is the private branch exchange (PBX), usually found in office buildings, hotels, department stores, and other business firms.

A newer type of service is called CENTREX, in which incoming calls can be dialed to any extension without an operator's assistance, and outgoing and intercom calls can be dialed by the extension users. This equipment can be located either on telephone company premises or on the customer's premises. CENTREX is currently replacing PBX in popularity among business and industrial users which handle a very large volume of calls. However, PBX is still more popular with smaller users.

Other communications services provided by telephone companies include conference equipment installed at a PBX to permit conversations among several telephone users simultaneously; mobile radio-telephones in automobiles, boats, airplanes and trains; and telephones equipped to answer calls automatically and to give and take messages by recordings.

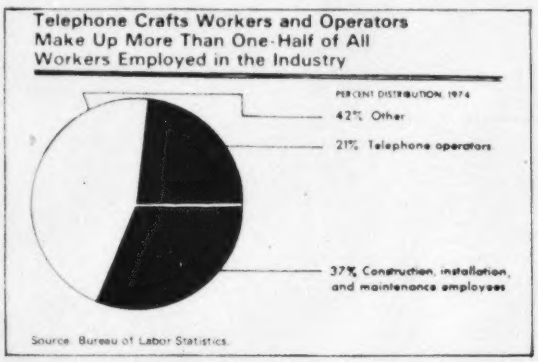
Telephone companies also build and maintain most of the vast network of cables and radio-relay systems for communications services, including those joining the thousands of broadcasting stations all over the nation. These services are leased to networks and their affiliated stations. Telephone companies also lease data and private wire services to business and government offices.

The Bell System owns about 4 out of 5 of the Nation's domestic telephones.

Independent telephone companies own the remainder. There are approximately 1,655 independent telephone companies in the United States. General Telephone and Electronics Corp. in Stamford, Conn., United Utilities, Inc. in Kansas City, and Continental Telephone Corp. in Chantilly, Va. service about 2 out of every 3 telephones owned by independent companies.

Telephone Occupations

Although the telephone industry requires workers in many different occupations, telephone craft workers and operators make up more than one-half of all workers. (See accompanying chart.)


Telephone Crafts Workers and Operators Make Up More Than One-Half of All Workers Employed in the Industry
PERCENT DISTRIBUTION, 1974
42% Other
21% Telephone operators
37% Construction, installation, and maintenance employees
Source: Bureau of Labor Statistics.

Telephone craft workers install, repair, and maintain telephones, cables, switching equipment, and message accounting systems. These workers can be grouped by the type of work they perform: construction workers place, splice, and maintain telephone wires and cables; installers and repairers place, maintain, and repair telephones and private branch exchanges (PBX) in homes and offices and other places of business; and central office craft workers test, maintain, and repair equipment in central offices.

Operators make telephone connections; assist customers in specialized services, such as reverse-charge calls; and give telphone information.

More than one-fifth of all telephone industry employees are clerical workers. They include stenographers, typists, bookkeepers, office machine and computer operators, keypunch operators, cashiers, receptionists, file clerks, accounting and auditing clerks, and payroll clerks. Clerical workers keep records of services, make up and send bills to customers, and prepare statistical and other reports.

About one-tenth of the industry's employees are professional workers. Many of these are scientific and technical personnel such as engineers and drafters. Engineers plan cable and microwave routes, central office and PBX equipment installations, new buildings, the expansion of existing structures, and solve other engineering problems.

Some engineers also engage in research and development of new equipment. Many top managers and administrators have engineering backgrounds. Other professional and technical workers are accountants, personnel and labor relations workers, public relations specialists and publicity writers, computer systems analysts, computer programmers, and lawyers.

Nearly one-tenth of the industry's employees are business and sales representatives who sell new communications services, directory advertising, and handle requests for installing or discontinuing telephone service.

About 3 percent of the industry's workers maintain buildings, offices, and warehouses; operate and service motor vehicles; and do other maintenance jobs in offices and plants. Skilled maintenance workers include stationary engineers, carpenters, painters, electricians, and plumbers. Other workers employed by the telephone industry are janitors, porters and guards.

Central Office Craft Occupations

Nature of the Work

Telephone companies employed about 110,000 craft workers in 1974 to maintain and repair the complex equipment in their central offices. Most worked as frame wirers, repairers, and trouble locators.

Frame wirers connect and disconnect wires that run from telephone lines and cables to equipment in central offices.

Frame wirers make connections for new telephones. (South Central Bell)

Connections are made by soldering wires to terminal lugs. They make these changes when new phones are installed, existing ones are removed, or numbers are changed. **Central office repairers** maintain the switching equipment that automatically connects lines when customers dial numbers. **Trouble locators** work at special switchboards to find and analyze trouble spots reported on customer's lines. They also work with other employees, such as central office repairers and cable splicers, who help find the cause of trouble and make repairs.

Training, Other Qualifications, and Advancement

Telephone companies give classroom instruction and on-the-job training to new central office craft employees. Often classrooms are supplied with equipment similar to that which the trainee will be using on the job. Trainee jobs generally are filled by employees already with the company, such as telephone operators, and occasionally by workers hired from outside. Usually, trainees are assigned to the starting job of frame wirer, and take basic courses in telephone communications. They gain practical experience by observing and helping experienced frame wirers under the direction of supervisors. With additional training and experience, a frame wirer can advance to central office repairer or trouble locator. At least 5 years usually are necessary for an inexperienced worker to advance to the top pay rate in either of these two jobs.

Since electrical wires are usually color coded, persons who are considering careers in central office crafts should have good eyesight—no color blindness. They also should be able to work closely with others because teamwork often is essential in solving complex maintenance problems. A basic knowledge of electricity and electronics and telephone training in the armed services are helpful.

Telephone companies give central office craft employees continued training throughout their careers to keep them abreast of the latest developments. As new types of equipment and tools and new maintenance methods are introduced, employees are sent to schools for courses of varying duration.

Central office craft workers who have managerial ability can advance to supervisory positions.

CENTRAL OFFICE EQUIPMENT INSTALLERS

Nature of the Work

Central office equipment installers set up complex switching and dialing equipment in central offices of telephone companies. They assemble, wire, adjust, and test this equipment to meet manufacturer's standards for efficiency and dependability. They may install equipment in a new central office, add equipment in an expanding office, or replace outmoded equipment.

About 30,000 installers were employed in 1974. Most work for manufacturers of central office equipment. Others work directly for telephone companies or for private contractors who specialize in large-scale installations.

Many central office equipment installers are assigned to areas that include several states, and they therefore must travel frequently. When installing a switchboard in a small community, an installer may work with only one or two other installers. On large jobs, however, such as a long-distance toll central in a big city, hundreds of installers are required.

Training, Other Qualifications and Advancement

Individuals considering careers as central office equipment installers should have good eyesight—no color blindness. They should be able to work with others, for teamwork is often essential to solving a complex problem.

New employees receive on-the-job training and classroom instruction. They attend classes the first few weeks to learn basic installation methods before starting on-the-job training. After several years of experience, they may qualify as skilled installers. Training, however, continues even after they become skilled. Additional courses are given from time to time to improve their skills and to teach new techniques in installing telephone equipment.

Installers who have managerial ability can advance to supervisory positions.

Installer wires a new distribution frame and switching equipment. (South Central Bell)

LINE INSTALLERS AND CABLE SPLICERS

Nature of the Work

The vast network of wires and cables that connect telephone central offices to each other and to customers' telephones and switchboards is constructed and maintained by line installers and cable splicers and their helpers. Telephone companies employed about 55,000 of these workers in 1974: 33,000 cable splicers, 15,000 line installers, and 7,000 helpers, laborers, and other workers.

To construct new telephone lines, **line installers** place wires and cables that lead from the central office to customers' premises. They use power-driven

equipment to dig holes and set in telephone poles which support cables. Line installers climb the poles to attach the cables, usually leaving the ends free for cable splicers to connect later. In cities where telephone lines are below the streets, installers place cables in underground conduits. On construction jobs, installers work in crews of two persons or more. A supervisor directs the work of several crews.

When wires or cables break or a pole is knocked down, line installers are often called upon to make emergency repairs. These repairs are most common in parts of the country that have hurricanes, tornadoes, and heavy snowfalls. The line crew supervisor keeps in close contact with the central office, which directs the crew to problem locations on the lines. Some installers periodically inspect sections of lines in rural areas and make minor repairs.

After line installers place cables on poles or underground, **cable splicers** generally complete the line connections. Splicers work on poles, aerial ladders and platforms, in manholes, or in basements of large buildings. They connect individual wires within the cable and rearrange wires when lines have to be changed. At each splice, they either wrap insulation around the wires and seal the joint with a lead sleeve or cover the splice with some other type of closure. Usually, they fill the cable sheathing with compressed air to keep out moisture.

Splicers install terminal boxes or new cables. Often these boxes are placed in basements of apartment buildings. Later, a telephone installer will connect customers' telephones to the terminal box.

Splicers also maintain and repair cables. The preventive maintenance work that they do is extremely important, because a single defect in a cable may cause a serious interruption in service.

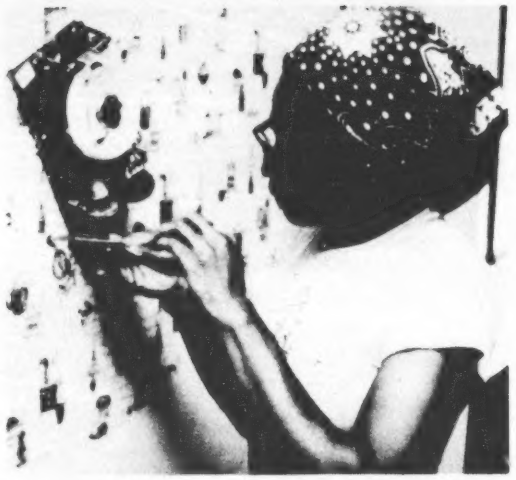
Cable splicers connect individual wires within the cable. (South Central Bell)

Many trouble spots are located through air pressure or electric tests.

Training, Other Qualifications, and Advancement

Telephone companies hire inexperienced workers to train for jobs as line installers or cable splicers. Knowledge of the basic principles of electricity and telephone training in the armed services are helpful. Physical examinations usually are given to prospective employees, since some line and cable work is strenuous, requiring workers to climb poles and lift lines and equipment. The ability to distinguish color also is important because wires usually are coded by color.

Telephone companies have training programs for line installers and cable



Each day in the United States thousands of telephones must be installed or repaired. (South Central Bell)

splicers that include classroom instruction as well as on-the-job training. Classrooms are equipped with actual telephone apparatus, such as poles, cable supporting clamps, and other fixtures to simulate working conditions as closely as possible. Trainees learn to climb poles and are taught safe working practices to avoid falls and contact with power wires. After a short period of classroom training, some trainees are assigned to a crew to work with experienced line installers and cable splicers under the supervision of a line supervisor.

Line installers and cable splicers continue to receive training throughout their careers, to qualify for more difficult assignments and to keep up with technological changes. Those having the necessary qualifications find many additional advancement opportunities in the telephone industry. For example, a line installer may be transferred to telephone installer and later to telephone repairer or other higher rated jobs.

Learning to climb and work on poles is part of the training for line installers and cable splicers. (South Central Bell)

TELEPHONE AND PBX INSTALLERS AND REPAIRERS

Nature of the Work

Telephone installers and repairers are the largest group of telephone craft workers; about 115,000 were employed in 1974. They install and service telephones and switchboard systems such as PBX and CENTREX on the customers' property and make repairs on the equipment when trouble develops. These workers generally travel to customers' homes and offices in trucks equipped with telephone tools and supplies. When customers move or request new types of service, they relocate telephones or make changes on existing equipment. For example, they may install a

switchboard in an office, or change a two-party line to a single-party line in a residence. Installers also may fill a customer's request to add an extension in another room, or to replace an old telephone with a new model. Although some installers and repairers do a variety of work, most specialize in one or two jobs described below.

Telephone installers

Telephone installers install and remove telephones in homes and business places. They connect telephones to outside service wires and sometimes must climb poles to make these connections. Occasionally, especially in apartment buildings, the service wires or terminals are in the basement of the building in which the installation or removal is being done. Telephone installers are sometimes called station installers.

Telephone installers must climb poles to make wire connections. (South Central Bell)

PBX installers

PBX installers perform the same duties as telephone installers, but they specialize in more complex telephone system installations. They connect wires from terminals to switchboards and make tests to check their installations. Some PBX installers also set up equipment for radio and television broadcasts, mobile radiotelephones, and data processing equipment.

Telephone repairers

Telephone repairers, with the assistance of trouble locators in the central office, locate trouble on customers' equipment and make repairs to restore service.

PBX repairers

PBX repairers, with the assistance of trouble locators, locate trouble on customers' PBX, CENTREX, or other complex telephone systems and make the necessary repairs. They also maintain associated equipment such as batteries, relays, and power plants. Some PBX repairers maintain and repair equipment for radio and television broadcasts, mobile radiotelephones, and data processing equipment.

After installing the unit, the PBX repairer checks the system. (South Central Bell)

Training, Other Qualifications, and Advancement

Telephone companies give new service workers classroom instruction and on-the-job training. They train inexperienced people as well as their own employees, such as telephone operators, for telephone installation and repair jobs. Applicants need good eyesight—no color blindness. Tests are given to help determine the applicant's aptitude for the work. Companies train experienced employees, such as telephone installers and repairers and cable splicers, for PBX installation and repair work.

Telephone operator working at the switchboard. (South Central Bell)

Classroom training usually is designed to simulate actual working conditions. For example, telephone installer trainees are instructed in classrooms equipped with telephone poles, lines and cables, terminal boxes, and other equipment. They practice installing telephones and connecting wires just as they would in the field. After a few weeks in the classroom, trainees are assigned to the field for on-the-job training by experienced workers, often supervisors.

Telephone service workers continue to receive training throughout their careers, to qualify for more responsible assignments and to keep up with technical changes. Those who have managerial ability can advance to supervisory jobs.

Employment Outlook

Telephone industry employment is expected to increase about as fast as the average for all industries through the mid-1980's. In addition to the jobs from employment growth, tens of thousands of openings will arise each year because of the need to replace experienced workers who retire, die, or leave their jobs for other reasons.

Employment will grow primarily because rising population and higher incomes will increase the need for telephone service. Greater demand for transmission of computer-processed data and other information via telephone company lines also will stimulate employment growth. Labor saving innovations, however, will keep employment from growing as rapidly as telephone service.

Employment of telephone operators is expected to decline slightly. If the trend in the number of telephone companies charging customers for directory assistance calls continues; more people will dial numbers direct and use telephone directories to locate needed numbers, thus reducing the need for operators. Technological innovations will restrict employment growth in some skilled crafts. For example, mechanical improvements, such as pole-lifting equipment and earth-boring tools, will limit employment of line installers by increasing their efficiency. On

the other hand, new technology is expected to increase the demand for engineering and technical personnel, especially electrical and electronic engineers and technicians, computer programmers, and systems analysts. Employment in administrative and sales occupations will rise as telephone business increases.

Earnings and Working Conditions

A telephone employee usually starts at the minimum wage for the particular job. Advancement from the starting rate to the maximum rate generally takes 5 years, but operators and clerical employees of some companies may reach the maximum rate in 4 years.

More than two-thirds of the workers in the industry, mainly telephone operators and craftworkers, are members of labor unions. The two principal unions representing workers in the telephone industry are the Communications Workers of America and the International Brotherhood of Electrical Workers, but many other employees are members of the 13 independent unions which form the Alliance of Independent Telephone Unions.

Union contracts govern wage rates, wage increases, and the amount of time required to advance from one step to the next for most telephone workers. The contracts also call for extra pay for work beyond the normal 6 to 8 hours a day, or 5 days a week, and for all Sunday and holiday work. Most contracts provide a pay differential for night work.

Overtime work sometimes is required, especially during emergencies, such as floods, hurricanes, or bad storms. During an "emergency call-out," which is a short-notice request to report for work during nonscheduled hours, workers are guaranteed a minimum period of pay at the basic hourly rate. Travel time between jobs is counted as worktime for craft workers under some contracts.

Paid vacations are granted according to length of service. Usually, contracts provide for a 1-week vacation beginning with 6 months of service; 2 weeks for 1 to 7 years; 3 weeks for 8 to 15 years; 4 weeks for 16 to 24 years; and 5 weeks for 25 years and over. Depending on locality, holidays range from 9 to 11 days a year. Most telephone workers are covered by paid sick plans and group insurance which usually provide sickness, accident, and death benefits, and retirement and disability pensions.

The telephone industry has one of the best safety records in American industry. The number of disabling injuries has been well below the average.

Sources of Additional Information

More details about employment opportunities are available from the telephone company in your community or local offices of the unions that represent telephone workers. If no local union is listed in the telephone directory write to:

Alliance of Independent Telephone Unions, P.O. Box 5462, Hamden, Conn. 16518.

Communication Workers of America, 1925 K St. NW., Washington, D.C. 20006.

International Brotherhood of Electrical Workers, 1200 15th St. NW., Washington, D.C. 20005.

United States Independent Telephone Association, 1801 K St. NW., Suite 1201, Washington, D.C. 20006.

THE ELECTRONICS MANUFACTURING INDUSTRY

An astronaut, a doctor, a mechanic, and a business executive all have something in common; without electronic devices they would be unable to do much of their work. We would never have reached the moon without the thousands of people working in electronics research and production. Nor would doctors be able to diagnose and treat many diseases without modern electronic machines. Mechanics use electronic testing equipment to locate malfunctioning parts in numerous types of machines and engines. Business executives also owe a lot to electronics. Electronic computers, for example, have helped them in such areas as inventory control, market research, and production scheduling.

Nature and Location of the Industry

The electronics industry dates back to the early 1920's when the first radios were produced. By the end of World War II, the industry had diversified its production to include defense equipment. With the development of television and the computer, the electronics industry expanded even further to manufacture a wide range of products.

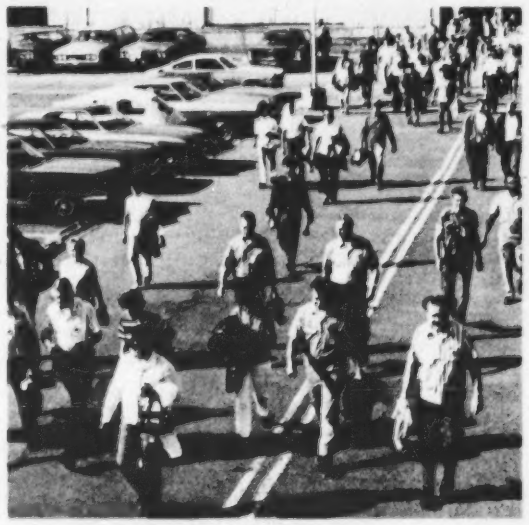
Today, the industry is divided into four main market areas: government products, industrial products, consumer products, and components. Products sold to the government make up a large portion of electronic sales. Included in government purchases are widely different products such as missile and space guidance systems, communications systems, and other electronic goods used in medicine, education, crime detection, and traffic control.

Electronic products have become an important part of daily business operations. Industrial purchases include computers, radio and television broadcasting equipment, and production control equipment.

Consumer products are probably the most familiar types of electronic products. Every day thousands of people buy television sets, radios, microwave ovens, stereos, and calculators.

Components are needed to manufacture and repair electronic products. Some of the most well-know components are capacitors, switches, transistors, relays, television picture tubes, and amplifiers.

Nearly 1.5 million workers were employed in the electronics industry in 1974. About 1,025,000 worked in plants that produce end products for government, industrial, and consumer use. The rest worked in plants that made electronic components.



Workers leaving assembly plant. (The Boeing Company)

Electronics manufacturing workers are located in all parts of the country, but the majority of the jobs in 1974 were in eight states: California, New York, Illinois, Massachusetts, Pennsylvania, Indiana, New Jersey, and Texas. Metropolitan areas with large numbers of electronics manufacturing workers include Los Angeles, Chicago, New York, Philadelphia, Newark, Boston, Baltimore, Indianapolis, and Dallas.

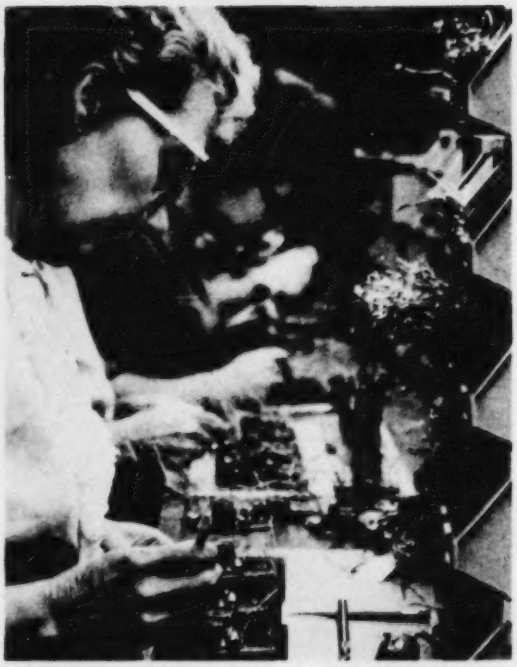
In addition to electronics manufacturing plants, electronics workers were employed by the Federal Government in activities such as research development and contract negotiations. Universities and nonprofit research centers employed a relatively small number of electronics workers.

Occupations in the Industry

A wide variety of jobs exist in the electronics manufacturing industry. More than half of all workers are in plant jobs that include production, maintenance, transportation, and service occupations. The rest are scientists, engineers, and other technical workers, and administrative, clerical, and salesworkers.

Professional and Technical Occupations. The electronics industry is very dependent on research and development. As a result, a large proportion of its workers are in engineering, scientific, and other technical jobs. Engineers and scientists alone make up about 1 out of every 9 electronics workers.

Electrical and electronics engineers, the largest group of engineers in the industry, work on research and development, production, and quality control problems. Most of these engineers are highly specialized and may work in a specific area such as the design and implementation of solid-state circuitry in radar, computers, and calculators.



These assemblers are putting together components for push button dial telephones. (Western Electric)

Mechanical engineers help develop new products, tools, and equipment by setting requirements for the strength of materials and designs. Industrial engineers work on production problems such as devising more efficient methods in manufacturing processes or plant layout. Chemical, metallurgical, and ceramic engineers also work for electronics companies.

Physicists work on research and development projects such as developing uses for solid-state circuitry or designing integrated circuits for satellites.

Chemists and metallurgists work mainly in research and in materials preparation and testing. Mathematicians and statisticians help engineers and scientists on complex mathematical and statistical problems, especially in the design of military and space equipment and computers. Statisticians also are

employed in quality control, production scheduling, and sales analysis and planning. Industrial designers are concerned with the design of electronic products and the equipment used to manufacture them.

Technicians—such as electronics technicians, drafters, engineering aides, laboratory technicians, and mathematical assistants—make up about 1 out of every 20 electronics manufacturing workers. Many electronics technicians help engineers design and build experimental models. They also set up and repair electronic equipment for customers. Other electronics technicians do complex inspection and assembly work. Drafters prepare drawings from sketches or specifications furnished by engineers.

Engineering aides assist engineers by making calculations, sketches, and drawings, and testing electronic components and systems. Laboratory technicians help physicists, chemists, and engineers in laboratory analyses and experiments. Mathematical assistants follow procedures outlined by mathematicians to solve problems. They also operate test equipment to develop computers and other electronic products.

Technical writers prepare training and technical manuals that describe the operation and maintenance of electronic equipment. They also prepare catalogs, product literature, and contract proposals. Technical illustrators draw pictures of electronic equipment for technical publications and sales literature.

Plant Occupations. About half of electronics manufacturing employees work in plant operations: assembly, capacitor and coil winding, inspecting, machining, fabricating, processing, and maintenance.

Assembly Occupation. Assemblers, most of whom are semiskilled workers, make up the largest group of employees. Most end products are assembled by hand with small tools, soldering irons, and light welding machines. Assemblers use diagrams to guide their work. Some assembly is done by following instructions presented on color slides and tape recordings. Color slide projectors flash a picture of an assembly sequence on a screen, while the assembler listens to recorded directions.

Assemblers making wire "bundles" which will be installed in aircraft. (McDonnell Douglas Corporation)

Precision assemblers and electronics technicians install components and subassemblies in complex products such as missiles. They also help make experimental models. Most of these workers are employed in the manufacture of military and industrial electronic equipment.

Machines are used in some assembly work. For example, in putting together circuit boards, automatic machines often are used to position components on boards and to solder connections. Here the assemblers work as machine operators or loaders. Most components are put together by machines, since their assembly involves simple and repetitive operations. Even some types of

miniaturized semiconductors and other components, made with parts small enough to pass through a needle's eye, are assembled by machines.

Hand assembly is needed for some items, such as receiving tubes and some types of resistors and diodes. Hand assemblers may perform only a single operation as components move down the production line, but some put together complete components. Tiny parts often are assembled under magnifying lenses or microscopes. Precision welding equipment may be used to weld connections in microminiature components and circuit assemblies.

The assembly steps in making this product are controlled by operators peering through microscopes. (Western Electric)

Fabricating Occupations. Fabricating workers are employed in many electronics manufacturing plants.

Inspection Occupations. Inspection begins when raw materials enter the plant and continues through manufacturing. Some inspection jobs require electronics technicians who have years of experience. These jobs are commonly found in complex production work such as the manufacture of computers and spacecraft. Most inspectors, however, do not need extensive technical training.

Some inspectors check incoming parts and components supplied by other firms. They may have job titles that indicate the work they do, such as incoming materials inspector or parts inspector.

During manufacturing, components are either checked manually by workers using test meters or routed mechanically through automatic test equipment. Although many of these workers simply are called testers, others have job titles that reflect the type of components they inspect, such as transformer-tester or coil-tester. Some automatic equipment can check components, produce a punched tape of the results, and sort the components into batches for shipping. Workers who feed or monitor automatic equipment often are called test-set operators or testing-machine operators.

Electronic assembly inspectors examine assembled products to make certain that they conform to blueprints and specifications. They inspect wiring, electrical connections, and other critical items to make sure everything will work properly.

Maintenance Occupations. Many workers repair and maintain machinery and equipment. Skilled electricians are responsible for the proper operation of electrical equipment.

Training, Other Qualifications, and Advancement

Training requirements for jobs in electronics manufacturing plants range from a few hours of on-the-job training to years of specialized preparation. Beginning engineering jobs usually are filled by recent college graduates, but

some positions call for advanced degrees. A small number of workers without college degrees, however, are upgraded to professional engineering classifications from occupations such as engineering assistant and electronics technician. Workers who become engineers in this way usually take advanced electronics courses in night school or in other training programs. To keep up with new developments and to qualify for promotion, professional and technical personnel obtain additional training, read technical publications, and attend lectures and technical demonstrations.

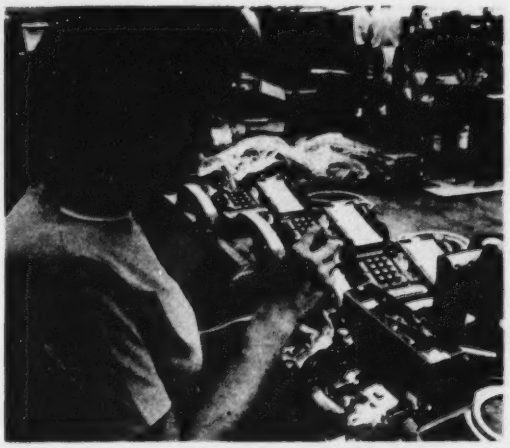
Almost all mathematicians, physicists, and other scientists employed in electronics manufacturing have college degrees; most have advanced degrees.

Technicians generally need specialized training to qualify for their jobs. Most electronics technicians attend either a public, private, or Armed Forces technical school. Some complete 1 or 2 years of college in a scientific or engineering field, and some receive training through a 3- or 4-year apprenticeship program. High school graduates who have had courses in mathematics and science are preferred for apprenticeship programs.

Some workers advance to electronics technician positions from jobs such as tester or laboratory assistant. A relatively small number of plantworkers become technicians. Opportunities for advancement are improved by taking courses either in company operated classes, night school, junior college, or technical school, or by correspondence.

Electronics technicians need good color vision, manual dexterity, and good eye-hand coordination. Some technicians who test radio transmitting equipment must hold licenses from the Federal Communications Commission as first- or second-class commercial radio-telephone operators.

Formal training is not necessary for workers entering plant jobs, but a high school diploma or its equivalent is sometimes required. Job applicants may have to pass aptitude tests and demonstrate skill for particular types of work. A short period of on-the-job training generally is provided for inexperienced workers. Assemblers, testers, and inspectors need good vision, good color perception, manual dexterity, and patience.



Assembler installing equipment in a telephone system. (Western Electric)

Employment Outlook

Employment in electronics manufacturing is expected to increase faster than the average for all industries through the mid-1980's. In addition to the jobs resulting from employment growth, large numbers of openings will arise as experienced workers retire, die, or take jobs in other industries.

Production of electronic products will increase as business executives decide to buy more computers and other electronic

equipment to automate paper work and production processes. Business spending for electronic communication and testing equipment also will grow. The demand for television receivers, videotape recorders stereo systems, calculators, and two-way car radios will rise as population and personal incomes grow. Government purchases for defense will continue to account for a large proportion of electronics manufacturing output. An increasing share of government purchases, however, is likely to be for electronic equipment used in medicine, education, pollution abatement, and other fields.

Although employment in the electronics industry is expected to grow over the long run, it may fluctuate from year to year, because of changes in economic activity and defense spending. As a result, job openings may be plentiful in some years, scarce in others.

The rates of employment growth will vary among occupational groups and individual occupations. For example, employment of skilled maintenance workers is expected to rise at a more rapid rate than total employment, because of the need to repair the increasing amounts of complex machinery. On the other hand, employment of assemblers probably will rise at a slower rate, because of the growing mechanization and automation of assembly line operations.

Employment of engineers, scientists, and technicians is expected to increase faster than total employment, because of continued high expenditures for research and development and the manufacture of more complex products. Among professional and technical workers, the greatest demand will be for engineers, particulary those who have a background in certain specialized fields, such as quantum mechanics, solid-state circuitry, product design, and industrial engineering. Many opportunities also will be available for engineers in sales departments because the industry's products will require sales personnel with highly technical backgrounds. The demand for mathematicians and physicists will be particularly good because of expanding research in computer and laser technology.

Working conditions in electronics manufacturing compare favorable with those in other industries. Plants are usually well-lighted, clean, and quiet. Many plants are relatively new, and are located in suburban and semirural areas. The work in most occupations is not strenuous but assembly-line jobs may be monotonous.

The injury rate in electronics manufacturing has been far below the average in manufacturing as a whole, and injuries usually have been less severe.

Sources of Additional Information

Information about careers in this field can be obtained from the public relations departments of electronics manufacturing companies, the unions previously listed, and from:

Electronic Industries Association, 2001 Eye St. NW , Washington, D.C. 20006.